16 PAGES.

Norfolk Virginian.

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VOL. LI—NO. 33. NORFOLK, VA., SUNDAY DECEMBER 29. 1895. PRICE 2 CENTS

PHOTOGRAPHING STARS

An Interesting Interview With the Director Of the Harvard Observatory.

HOW THE WONDERFUL WORK IS DONE.

Marvelous Collection of Plates Now at Harvard—The Observatory at Arequipa, Penn—Need of More Telescopes South of the Equator—More Telescopes Useless North.

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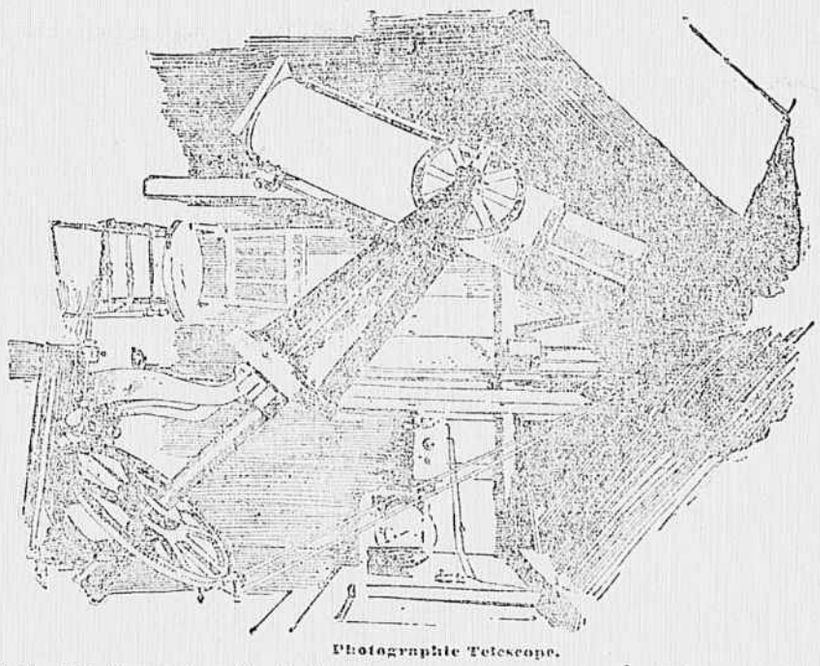
Boston, Dec. 28.—Particular attention has again been drawn to the work of the Harvard astronomical observatory, both by the discovery of Nova Carinae, a "new" star in the constellation of Carina and the shipment of the magnificent Bruce photographic telescope to the astronomical station at Arequipa. During the past 2,000 years, from the beginning of the record by the famous astronomer Hippacchus, the discoverer of the first so-called "new star," B. C. 134, down to the present day, only fifteen of this description have been noted, an average of less than one in a century. What a feather it is therefore for the cap of the Harvard observatory to have made the latest addition to this notable list and, more even than this, to have won this credit twice in succession. Before the coming into view of Nova Carinae, the last in line was Nova Normae, also a discovery of the Harvard observatory, and, oddly enough, exactly two years earlier.

These stars, technically styled "new," are not permanent additions to the heavenly host. They come into being or into sight only to glow with an intensifying radiance for a few weeks or months and then to fade away by dissolution into gaseous nebulae. The special interest attaching to these transitory beacons of the sky is in the material which they afford to students for instructive analysis and comparison



Photographic Telescope.

and the light which they cast on the formation of the universe and its laws. Hence astronomical science seeks assiduously to determine the constituents of these bodies and their features of resemblance or divergence with reference to the permanent stars.

For the extension of this scientific investigation the Harvard observatory is to-day pre-eminently fitted. It is by no peculiar or unearned favor of fortune that this observatory is to-day in the forefront of discovery, but simply because of its unequal completeness of equipment in astronomical stations, appliances and observers. Its stations at Cambridge, Mass., and at Arequipa, in Peru, on the slope of the Andes, afford a complete field of view of the heavens surrounding both the Northern and Southern hemispheres. This comprehensive range of survey is necessarily beyond the reach of any single station, no matter how advantageously situated or superbly equipped for observation.

It has also at Arequipa the largest refracting telescope in use on the Southern hemisphere, at a point where the steadiness and clearness of the atmosphere are exceptionally favorable for astronomical work. This instrument, a 13-inch Boyden telescope, is not of large size compared with the 36-inch Lick refractor or with many others north of the equator, but its observations are of great comparative value in view of the fact that there are so few telescopes of even moderate power in the stations south of the equator.

By the co-operation of the two stations under one general director or head every important piece of work that is undertaken can be extended according to an uniform plan so as to include stars in all parts of the sky, ranging from pole to pole. It has the most minutely complete chart of the heavens which has ever been prepared and it is the only observatory which it now making yearly a complete photograph of the heavens visible from both Northern and Southern hemispheres. In the conduct of the work carried on at the two observing stations admirable arrangements have been made to secure facility of reference and co-operation, and telegraphic communication is used when delay would impede or prevent the requisite investigation.

To the high intelligence and completeness of these provisions must be added the special equipment of the observatory in photographic telescopes and a collection of plates of priceless value. The Harvard observatory has the distinguished honor of having been the first to undertake stellar photography and of having carried the undertaking to proportions beyond any suggestion of rivalry. The first photographic image of a star was taken at the Cambridge observatory by Prof. G. P. Bond and J. A. Whipple on July 17th, 1850. A daguerrectype plate was used and only the brighest stars left a permanent image. A few years later the work was resumed with the use of the collodion process and glass plates, and many excellent photographs were thus obtained. In 1872 Dr. Henry Draper was first to succeed in making a photograph showing the lines in the spectrum of a star, and with the aid of more sensitive plates and other improved appliances the observatory during the past ten years has made great progress in the application of the art and in its collection of plates.

HOW STARS ARE PHOTOGRAPHED.

In photographing the stars a set of lenses prepared for the purpose taken the place of the object glass in the telescope and by the attachment of a prism to the lenses photographs of the stellar spectra are obtained. It is through the photographic telescopes that the recent discoveries of new stars have been made, for an examination of the exposed plates showed a marked difference in the spectra which is apparent even to an untrained eye.

With the use of the most sensitive plates the faintest stars visible to the eye through the telescope have been photographed, and, in the photographs of nebulae and the most distant stars, the astonishing result has been attained of the reproduction of stars too faint to be seen by the most powerful telescopes. The area of sky covered by the plate used by the Harvard Observatory is 100 square degrees, and as the total area of the sky is about 40,000 square degrees 400 plates are sufficient to map the entire sky. Complete photographs of the heavens have been repeatedly made by the observatory and individual stars and clusters and regions of the sky of special interest have been covered by elaborate series of plates of the utmost value to the students for the investigation of stellar problems. The collection of plates now stored at Cambridge, constructed especially for the purpose, exceeds 50,000 in number and the addition from year to year of about 7,000 plates is now going on.

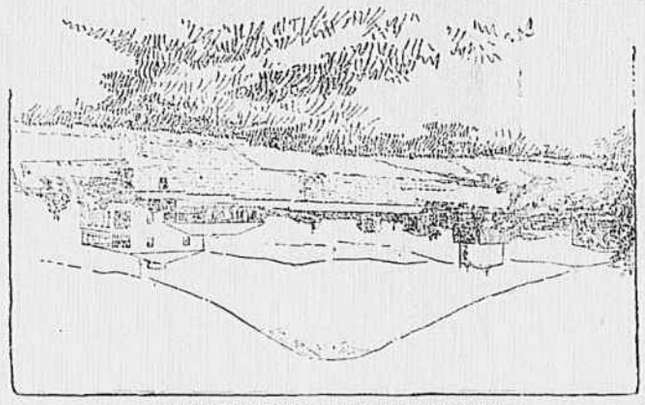
Sir Edwin Arnold has lately found cause for regret in the general limitation of modern astronomical work to the ascertainment of facts and in the failure of astronomers to "use the rich sublimity of the comic side of their business." The best thing that could happen to mankind, he says, would be if a great astronomer had been born a poet or if a great poet should become an astronomer. The astronomers of the Harvard Observatory are inclined to think, on the other hand, that the illumination of mankind is not really dependent on the conjunction of the poet and astronomer in the same person. The prolonged, patient, and acute observation, the careful weighing of the evidence, and the scientific attainment that are requisite for astronomical advances can hardly be reconciled with the poetic temperament or faculty, and it seems idle to complain because nature has not combined them. The observers at Cambridge and Arequipa are avowedly intent upon the accumulation of facts for the enrichment of our knowledge of the universe and its laws and they have faith that the field of poetical or speculative treatment will be better filled by Sir Edwin Arnold and other experts in this department of human endeavor.

EXTENSION OF THE WORK.

"What has been done recently for the extension of the work of the Harvard Observatory?" I asked of Prof. Edward C. Pickering, director of the observatory, in a recent call at the station in Cambride.

"A 24-inch photographic telescope has been provided and is now on the way to the station at Arequipa," he said. "This powerful telescope, when erected in a position so favorable for observation and photographic work, will be of much service in the determination of points now doubtful and generally in the extension of our knowledge of the stars visible from the Southern hemisphere. We have completed also and are now maintaining a series of stations for meteorological observations extending from Mollendo, at a point 100 feet above sea level to El Misti on the summit of a mountain 19,200 feet high. The intervening stations are Santa Ana, 3,000 feet above sea level; La Joya, 4,150 feet; Arequipa, 8,060 feet; Cuzco, 11,000 feet; Alto de los Hueses, 13,390 feet, and Mt. Blanc station on El Misti, 15,600.

"At the more elevated stations it is impracticable to keep observers continuously during the winter season, but this drawback has been obviated in part by the use of the meteorograph, an instru-



Arequipa Station From the Southwest.

ment operated by clock work and recording automatically wind direction and velocity, pressure, temperature and humidity. The meteorograph at the Mt. Blanc station makes each record on a separate roll of paper, and the five rolls are operated by the same clock which will run eight months without rewinding. The meteorograph on the summit of El Misti is in service at the highest elevation of any winter station in the world. This instrument was designed and made especially for this station and it will be very gratifying to us, if we succeed in making a continuous record at this and other stations in face of the apparent difficulties."

"What are the most urgent needs of astronomical research to-day?"

"An increase in the number of observing stations south of the equator," he replied, "and an increase in the power of the telescope in these southern stations. It is a singular fact, and one not very creditable to the discretion of our astronomical endowments, that the Northern hemisphere is so overlonded proportionally with observatories. Of the eighty telescopes in use to-day, with object glasses of twelve inches diameter or more, seventy-six are in stations north of the equator, and only four, or one-twentieth of the whole number, in stations in the Southern hemisphere. Of this scanty proportion, too, not one has an object glass exceeding thirteen inches in diameter, or, in other words, there is no refracting telescope south of the equator to-day of one-half the size of our largest instruments in North American or European stations. When we consider the comparative novelty and possibilities of the southern field of observation, it is really vexing to see endowment after endowment going into the erection of new Northern observatories or additional telescopes when the Southern hemisphere is so destitute.

"There is a misplaced local pride, too, on the part of well-meaning contributors which insists blindly on the erection of an observatory, as if it were a local monument or attraction. The atmosphere of any large city is inevitably clouded and unsatisfactory for an astronomical station, and the essential freedom from jarring cannot possibly be secured within city limits. Moreover, the introduction of electric light, brilliant and desirable as they are for city service, is found to interfere seriously with the observation of faint objects, such as comets, nebulae and zodiacal phenomena. In truth, the ideal place for the location of an observatory is in the heart of a great desert or on an isolated mountain peak, but these situations are doubtless less desirable than city streets for advertising purposes, if observatories are to be erected chiefly as memorial tablets or for the attractions of sight-seers."

POSSIBILITIES OF ASTRONOMY.

"What are the probalities or possibilities of marked advances in our scientific knowledge of the stars and planets?"

"Half a century ago," said Professor Pickering, "many people were inclined to look upon astronomy in the light of a dead science, and it must be confessed that there did not seem to be great encouragement for ambitious observers in the discovery of novelties with the appliances then at hand. But a great change for the better came with the application of the spectroscope and photography to astronomical research. The spectroscope may be regarded as second only to the telescope in the importance of its contributions to our knowledge of the physical properties of the stars. It has given us information of the origin and composition of the heavenly bodies otherwise unattainable and also of the velocity and peculiarities of their movements.

"The increase in the size and power of telescopic object glasses has been remarkable also during the half century just closed. In 1850 the largest refracting telescopes were those at the Russian National and Harvard observatories, both of 15-inch aperture. The object glass of the refractor at the Lick observatory to-day is thirty-six inches in diameter, and the one lately constructed for the Yerkes observatory of the Chicago University is forty inches in diameter. At stations where clear atmosphere permits the full utilization of the greater power of the enlarged telescopes their service in the extension of knowledge of the heavens is of high value.

"In photography as applied to astronomy the principal advance to be looked for is in the increase of sensitiveness of plates, but it is unfortunately true that certain difficulties in the way of their use will inevitably increase with the sensitiveness. The fogging of the plates on moonlight nights is already so great that long exposures cannot be made with telescopes of large angular aperture, and any marked increase of sensitiveness will make it impossible to work to advantage in the vicinity of a large city on account of the illumination of the atmosphere by artificial light. It will then be necessary to take the photographs in places far from centers of population and preferably at great elevations, where the reflecting atmosphere is diminished in amount.

"As to the possible enlargement by this or other means of the number of stars known to us no approximate limit can be fixed. It has been estimated that as many as twenty million distinct stars will appear upon the planisphere of the visible heavens when completed by the photographic reproduction of all stars down to the fourteenth magnitude. In the investigation of the planets, the application of photography is of comparatively slight service. This is particularly illustrated in the contrasted views of Mars, obtained from a photographic plate and by the drawings made from the telescopic observations of this planet.

"Of the invisible and immeasurable regions beyond the farthest reach of any instrument known to us to-day we can only conjecture by inferences from the heavens within our range of view. It is safe to say, however, that there is no evidence that we are approaching a limit in our knowledge of the extent of the universe."

Upon some points of recent and curious inquiry and speculation, Professor Pickering prefers to preserve his opinions. The visible stars are known to be of like character to our sun and may be centres of solar systems like ours, but the possible existence and number of invisible planets like our earth are still matters of surmise. As to the existence of vegetable and animal life in any of the planets there is still doubt and disagreement if not open controversy. By some astronomers it is confidently maintained that Mars and Venus in particular are adapted to sustain vegetable and even animal life. Venus is so constantly enveloped in clouds that observations are difficult, but this planet is said to be apparently passing through conditions like those of our own earth years ago. Its atmosphere is of twice the density of that of our earth and animals that may exist upon it would be modified correspondingly.

The atmosphere of Mars is about one-half as dense as that of the earth and this condition will produce a like modification of any life existing on this planet. That the surface of Mars is singularly marked by a number of lines is determined by such a concurrence of independent observations that it may now be safely accepted as a fact, but Percival Lowell is still in advance of the majority of astronomers in his positive conclusion that these lines are stretches of vegetation indicating the courses of irrigating canals constructed by creatures of high intelligence and powers. It is pointed out by the more conservative observers like Prof. Asaph Hall that Mars seen through the telescope is relatively like the moon seen by the naked eye, and the determination of even the largest objects on the face of the moon is still difficult and in dispute, as for example the question of the existence of bodies of water on this satellite.

ELIOT LORD.

HOW SERPENTS SLEEP

They Do Not Close Their Eyes Because They Have No Lids.

SOMETHING ABOUT NOCTURNAL SNAKES.

These Cat Eyed Reptiles Are Altogether Most Venemous and Dangerous—The Adventures of O'Reilly With a Puff Adder and Some Day Sleeping Tree Boars.

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One of the most curious facts with regard to snakes is that their eyes are never closed. Sleeping or waking, alive or dead, they are always wide-eyed. If we take a dead one and examine it closely we shall soon find the reason—there are no eyelids. The eye is protected only by a strong scale which forms a part of the epidermal envelope and is cast off in the piece with that every time the reptile moults. This eye plate is as clear and transparent as glass and allows the most perfect vision, while at the same time it is so hard and tough as to perfectly protect the delicate organ within from the thorns and twigs among which, in flight from enemies, or in pursuit of prey, the reptile so often hurriedly glides.

When we and other warm blooded animals sleep, our eyelids close to shut out light, while the pupil relaxes or opens. In serpents the action of the pupil is the reverse of ours—it contracts or closes as a cat's does in sunlight.

Only yesterday it was that I saw an example of this in one of my copperheads. These deadly vipers have eyes with a vertical pupil like the cat's. Now the copperhead was asleep for the pupil of the eye was hardly apparent.

It appeared like a fine hairlike mark of black, upon the eye-ball. With the intention of feeding him, I put a frog into his cage. On seeing the snake the frog was intensely alarmed and began jumping wildly against the glass. In one of its leaps it alighted on the head of the copperhead and awoke him. As I sat quite close to the cage I could observe most clearly the pupil dilating. Then his vibrating tongue came forth, feeling the air in his vicinity. He had probably been dreaming of frogs, for, as the creature jumped again, he darted open-mouthed upon it, and held it secure in his jaws. His eyes were not now marked with the hair-like line of black as before, but had quite an extensive pupil, vertically elongated, as if inclosed between two segments of a circle. Two hours after he had finished his mess I went again to the cage. The snake was lying coiled and certainly asleep with the same fine black line as before marked across his eyeball from above downwards. As I pounded on the cage with my fist to awake him I saw the pupil again slowly dilating until it grew as big as before. Then the inquiring tongue was pushed tremulously forth and he industriously set out to explore the corners of the cage evidently searching for another frog.

CAT-EYED SNAKES MOST DANGEROUS.

As the fiercest and most terrible of the predatory mammals are the great night-prowling cats so also in the serpent kingdom, the most potent in strength or venom, viz.' the viperidae and boidae, are cat-eyed and nocturnal. Except when they are thirsty you will rarely find them wandering in the daytime. The colubridae or common harmless snakes' eyes have round pupils and sleep at night, being active chiefly during the hours of sunlight.

During extensive travels in the wilder parts of the world in prosecution of the study of snakes, I have had many interesting adventures with sleeping ones. Some of these encounters had in them a seasoning of danger, while others were marked by a touch of the ridiculous, but all of them were amusing, and instructive, too, inasmuch as they showed the behavior of the sleepers before and after their waking.

I shall never forget my first meeting with a large puff adder, one of the most deadly of serpents in Currie's Kloof, near Grahamstown, in South Africa. Tired and exhausted with the heat of the sun, I had descended to the bed of a dried-up stream to lie down and rest beneath the leafy trees which shaded it. I chose a spot more than usually secluded, had taken off my coat and laid it on the grass and was about to stretch myself on the slope with my feet to a tree that was old and decaying, when I was struck by the strange beauty of what appeared to be a large fungus, such as often grows on ancient trees. It was quite close to the trunk between the protruding roots. It was colored differently from all the fungi I had previously seen. Deep velvet black and golden yellow it was. In form it was flat and circular and was about a foot in diameter. Charmed by its curious loveliness, I approached and stooped over to examine it. Horror of horrors! It was a frightful puff adder. At that time I was a beginner and knew little of snakes except what I heard or read. These dreadful puff adders are undoubtedly among the worst serpents in the world. Persons in South Africa had died of their bites within the year and every one told me that they could actually jump backwards for a distance of several feet. For a moment I stood there, still steaming, transfixed with fear and astonishment. My blood felt chilling in my veins. Would he jump and kill me as I stood? Knowing well that my life depended on caution, I began to move backwards as slowly as I could. When I got six feet away I felt safer, and then—strange compounds that men are—curiosity conquered fear, and I stopped to admire him. I gloated over his loveliness. I coveted him for a pet and determined to capture him alive. That he saw me I felt assured. His eyes were open. I hadn't yet fathomed the secret of his sleep.

A STRUGGLE WITH A PUFF ADDER

He was lying in a rat path evidently watching for rats and was too busy to notice me. Trusting that he would wait there I went for assistance and soon returned with a companion and a stout pole eight or ten feet long. Approaching cautiously I got this over his neck and pressed him forcibly to the ground. To prevent his getting loose, my companion also held on to it.

"Be careful to hold him down," said I, "for failure means death."

We probably pressed pretty heavily, for both were excited and apprehensive of danger, though fully determined to get him. Trusting my companion to hold the stick across his neck, I manager to get my fingers round his throat just behind the head. I lifted him up. He was as thick as a man's arm, but not more than two and a half feet in length. To my astonishment, he had never moved, and even now that I had him by the throat the only sign of life he gave was the exertion of his double pointed tongue. As my coat was lying on the grass, and I did not wish to go through the town in shirtsleeves, I determined to put it on, but how was I to do this, holding a living puff adder by the neck. I dared not transfer him from one hand to the other nor even to give him to my assistant. The consequences were too much to risk. As he was a short though thick snake, I determined to hold him as I had him and push my arm snake and all through the sleeve. My companion held the coat and I pushed my clutched fist into the sleeve. When he felt the cloth rubbing against his nose, he opened his mouth and clutched it with his fangs. He was then half way through the sleeve. Now he was thoroughly awake and gave every evidence of it by his violent contortions. He lashed himself about, opened his mouth in vain efforts to bite me and sent the venom from his mouth in streams over my fingers. The consequence was that I had to hold him as he was and go home in shirt sleeves with my coat thrown over my arm. He had really been asleep while I caught him and only woke up slowly after I had my fingers clutched round his throat.

Not all snake sleep so convenient for catching, in shady spots at the roots of trees.

DAY SLEEPING TREE BOAS.

At Maraval, near Port of Spain, the Island of Trinidad, one day when I was there, a large snake was discovered coiled in the top of the huge bamboos shading the reservoir which supplies the city with water. They telephoned me to come up. When I arrived I found the serpent had lashed himself securely in the very top of the bamboos, seventy feet above the water. The bamboo he was in was partially separated from the others, and as a wind was blowing pretty strongly it was swaying incessantly through the arc of some thirty feet. I saw from the ground that the snake was a python, short, or tree boa, decidedly nocturnal in his habits. Of course he was soundly asleep. There was only one way to get him—to cut down the bamboo and drop him in the water. Soon from the ground to its apex the branches were lashed with the blows of the fast-wielded cutlass. The leaves around him trembled with every stroke. Still he never moved. He slept through it all, and what is more, when at last the cutting was finished and the long bamboo fell out into the water, landing him in the middle of the reservoir, he wasn't in a bit of a hurry to unloose his coils. He wanted a few minutes to look round him and then swam out on to the bank, where he was very much surprised and indignant to find himself my prisoner with my fingers clutching his throat.

While hunting in the Island of Guadaloupe in the same Island of Trinidad, I had a curious interview with one of the same day-sleeping tree boas. At one of the streams coming down from the hills I was searching for the bothrops atrox, better known as the deadly fer de lance. As the banks where these snakes are most usually found were thickly covered with bush, I considered it better and safer to wait in the bed of the stream, where I could at once have both banks in view, and at the same time be out of danger of stepping incautiously upon one. To be sure, my feet were in the water, and I had often to wade to the knees, but that doesn't count in the tropics, where the water is warm and wetting easily dried. I had gone for some miles up the stream bed, when I came to a pool with a branch hanging out over the middle.

From the water to the branch was five feet or less and upon the latter I coiled and asleep, was a tree boa of the very same kind I had got at Maraval. That this fellow was asleep there was no doubt whatever. He never moved as I walked right up to him. He was coiled securely in the branches just on a level with my face. I approached so I looked clear into his eyes. The l

(Continued on Tenth Page.)